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(54) Optical disk apparatus

(57) An optical disk apparatus which incorporates an optical disk 10 and comprises an optical pickup 11, an angle-changing mechanism 16, and a drive shaft 17. The angle-changing mechanism 16 changes the angle between the recording surface of the optical disk 10 and the drive shaft 17. The apparatus has a jitter measuring circuit 14, a system controller 15, and a servo controller 12. The jitter measuring circuit 14 measures the jitter in a signal (RF signal) representing the data read from the optical disk 10. The system controller 15 generates an angle-correcting signal, which corrects the angle between the recording surface of the optical disk 10 and the drive shaft 17, thereby to optimize the jitter in the signal. The servo controller 12 drives the angle-changing mechanism 16 in accordance with the angle-correcting value generated by the system controller 15. Thus driven, the angle-changing mechanism 16 corrects the angle at which the drive shaft 17 is inclined to the recording surface of the optical disk 10.

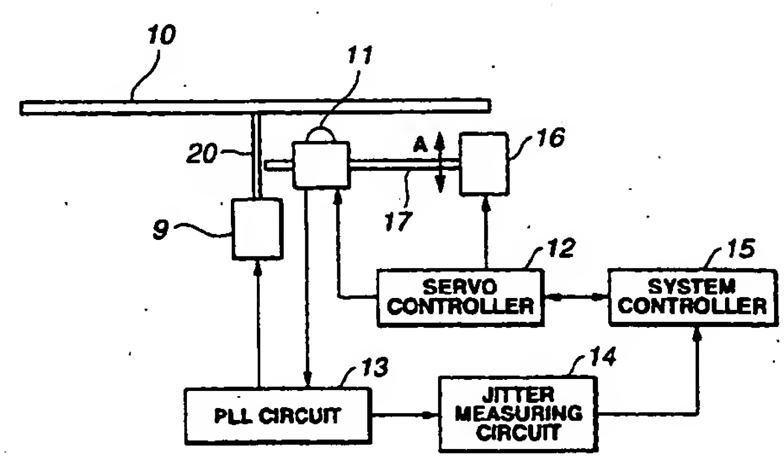

FIG.3

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ated by the angle-correcting value generating means.

[0016] In the optical disk apparatus of the invention, the angle between the recording surface of the optical disk and the drive shaft is corrected in accordance with the jitter in the signal representing the data read from the optical disk. Hence, the apparatus can generate a high-quality signal representing the data reproduced from the optical disk, i.e., a data signal containing but a small jitter, even if the optical disk undergoes physical warping.

[0017] As can be seen from the above, the jitter in a signal read from the optical disk is measured in the optical disk apparatus of the invention. An angle-correcting value for correcting the angle between the recording surface of the optical disk and the drive shaft is generated in order to optimize the jitter. The angle-correcting value is applied, thereby correcting the angle at which the drive shaft is inclined to the recording surface of the optical disk. Therefore, neither a radial skew sensor nor a servo circuit dedicated for the radial skew sensor are required. The optical pickup can be made small and compact, and the manufacturing cost of the apparatus can be reduced. Moreover, the apparatus can generate a high-quality signal representing the data reproduced from the optical disk, i.e., a data signal containing but a small jitter, even if the optical disk warps to different degrees at its center part and its circumferential part.

[0018] A preferred embodiment of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

FIG. 1 is a block diagram of a conventional optical-disk playback apparatus that comprises a radial skew sensor;
FIG. 2 is a diagram for explaining the skew angle between the recording surface of an optical disk and the drive shaft used in the apparatus of FIG. 1;
FIG. 3 is a block diagram of an optical-disk playback apparatus according to this invention;
FIG. 4 is a flow chart representing the algorithm for determining the motor position (inclination angle of the drive shaft) that is the most desirable for reducing jitter; and
FIG. 5 is a graph illustrating the relation between the jitter and the motor position.

[0019] FIG. 3 is a schematic representation of an optical-disk playback apparatus, which is an embodiment of the optical disk apparatus according to this invention. In particular, FIG. 3 shows the disk-driving section and head-driving section of the optical-disk playback apparatus.

[0020] As shown in FIG. 3, an optical disk 10 is connected to a shaft 20, which in turn is connected to a spindle motor 9. Thus, the optical disk 10 can be rotated by the spindle motor 9. An optical head, or optical pickup 11, has an objective lens (not shown). The distance between the objective lens and the optical disk 10 is adjusted in accordance with the control signal supplied from a servo controller 12. That is, the focusing of the optical pickup 11 is servo-controlled. While being its focusing is being so controlled, the optical pickup 11 applies a laser beam to a prescribed track on the optical disk 10, receives the beam reflected from the disk 10 and converts the beam to an RF signal. The RF signal is supplied to a PLL circuit 13. The PLL circuit 13 controls the spindle motor 9 so that the optical disk 10 may have a prescribed linear speed at a data-reading position.

[0021] The optical pickup 11 is mounted on a drive shaft 17; it can move along the shaft 17. The drive shaft 17 is arranged parallel to the recording surface of th optical disk 10. The drive shaft 17 is a so-called thread shaft or a screw shaft. When rotated by a thread motor (not shown), the drive shaft 17 moves the optical pickup 11 in the radial direction of the optical disk 10.

[0022] The optical-disk playback apparatus of the invention further comprises an angle-changing mechanism 16. The mechanism 16 is designed to correct th radial skew angle θ between the recording surfac of the optical disk 10 and the drive shaft 17. More precisely, the angle-changing mechanism 16 rotates the drive shaft 17 in one direction or the other indicated by arrows A shown in FIG. 3. In other words, the mechanism 16 inclines the drive shaft 17 to the recording surface of the optical disk 10. The mechanism 16 corrects the radial skew angle θ, rendering the drive shaft 17 nearly parallel to the recording surface of the disk 10. The angle θ is thereby made constant at both the center part of the disk 10 and the circumferential part thereof Though not shown in detail, the angle-changing mechanism 16 comprises a gear unit and an electric motor. The gear unit moves one end of the drive shaft 17 in one of the directions of arrows A (FIG. 3). The motor (e.g., a stepping motor) drives the gear unit.

[0023] The conventional optical-disk playback apparatus shown in FIG. 1 has a servo circuit (including components 108 and 107) that generates a skew servo signal from the angle signal supplied from the radial skew sensor 105. The optical-disk playback apparatus according to this invention has neither a servo circuit nor a radial skew sensor 105. The apparatus of the invention can yet correct the radial skew angle θ in the following way.

[0024] A PLL circuit 13 generates a binary RF signal. A jitter measuring circuit 14 detects the absolute value of the phase difference between the binary RF signal and a synchronizing clock signal. The phase difference detected is output, as jitter, to a system control 15. As indicated above, the jitter represents the quality of the signal reproduced or read from the optical disk 10. The greater the jitter, the lower the quality of the signal reproduced.

[0025] The system controller 15 causes the servo controller 12 to control the motor of the angle-changing

playback apparatus of FIG. 3 can be modified in various ways.

[0040] In a first modification of the apparatus shown in FIG. 3, an angle-correcting value (i.e., the value for changing the position of the motor incorporated in the angle-changing mechanism 16) is calculated before data is reproduced from the optical disk 10. The angle-correcting value is to change the radial skew angle to the value which optimizes the jitter value. To reproduce the data from the optical disk 10, the position of the motor is changed by the angle-correcting value thus calculated (i.e., the value for changing the position of the motor). Thereafter, data is reproduced from the optical disk 10.

[0041] In a second modification of the apparatus shown in FIG. 3, various angle-correcting values for optimizing the jitter value at a plurality of points in the radius of the optical disk 10 are calculated before data is reproduced from the optical disk 10. To reproduce the data from the optical disk 10, the angle-correcting values are sequentially applied, the first of which is either the value calculated for the point nearest the position where data is being reproduced or the value calculated for the point nearest the center or circumferential part of the optical disk 10.

[0042] In a third modification of the apparatus shown in FIG. 3, the angle-correcting value (i.e., the value for changing the position of the motor incorporated in the angle-changing mechanism 16) is calculated continuously, thereby continuously correcting the skew angle θ, throughout the process of reproducing data from the optical disk 10.

[0043] As has been described, the optical-disk playback apparatus according to the present invention need not have a radial skew sensor which is essential in conventional optical-disk playback apparatus. Hence, it does not require a servo circuit dedicated for applying a skew servo to an angle signal supplied from a radial skew sensor. With the optical-disk playback apparatus of the invention, it is therefore possible to render the optical pickup small and compact and to reduce the manufacturing cost of the apparatus. In addition, the apparatus can generate a high-quality signal representing data reproduced from an optical disk, i.e., a data signal containing but a small jitter, even if the optical disk warps to different degrees at its center part and its circumferential part.

Claims

1. An optical disk apparatus including a mechanism for correcting the angle between a recording surface of an optical disk and a drive shaft for moving an optical head in a radial direction of the optical disk, said apparatus comprising:

   jitter measuring means for measuring jitter contained in a signal which represents data reproduced from the optical disk; and

   angle-correcting value generating means for generating an angle-correcting value for correcting the angle between the recording surface of the optical disk and the drive shaft, thereby to optimize a jitter value,

   wherein the angle at which the drive shaft is inclined to the recording surface of the optical disk is corrected by the angle-correcting value generated by the angle-correcting value generating means.

2. An optical disk apparatus according to claim 1, wherein the angle-correcting value generating means is configured to calculate the angle-correcting value that optimizes the jitter value, and data is reproduced from the optical disk while applying the angle-correcting value thus calculated.

3. An optical disk apparatus according to claim 1, wherein the angle-correcting value generating means is configured to calculate various angle-correcting values that optimize the jitter value at a plurality of positions on the recording surface of the optical disk before data is reproduced from the optical disk, and the angle-correcting values thus calculated are sequentially applied, the first of which is either the value calculated for the point nearest the position where data is being reproduced or the value calculated for the point nearest a center or circumferential part of the optical disk, thereby to reproduce the data from the optical disk.

4. An optical disk apparatus according to claim 1, wherein the angle-correcting value generating means is configured to calculate continuously the angle-correcting value while data is being reproduced from the optical disk, and the data is reproduced from the optical disk by applying the angle correcting value calculated by the angle-correcting value generating means.

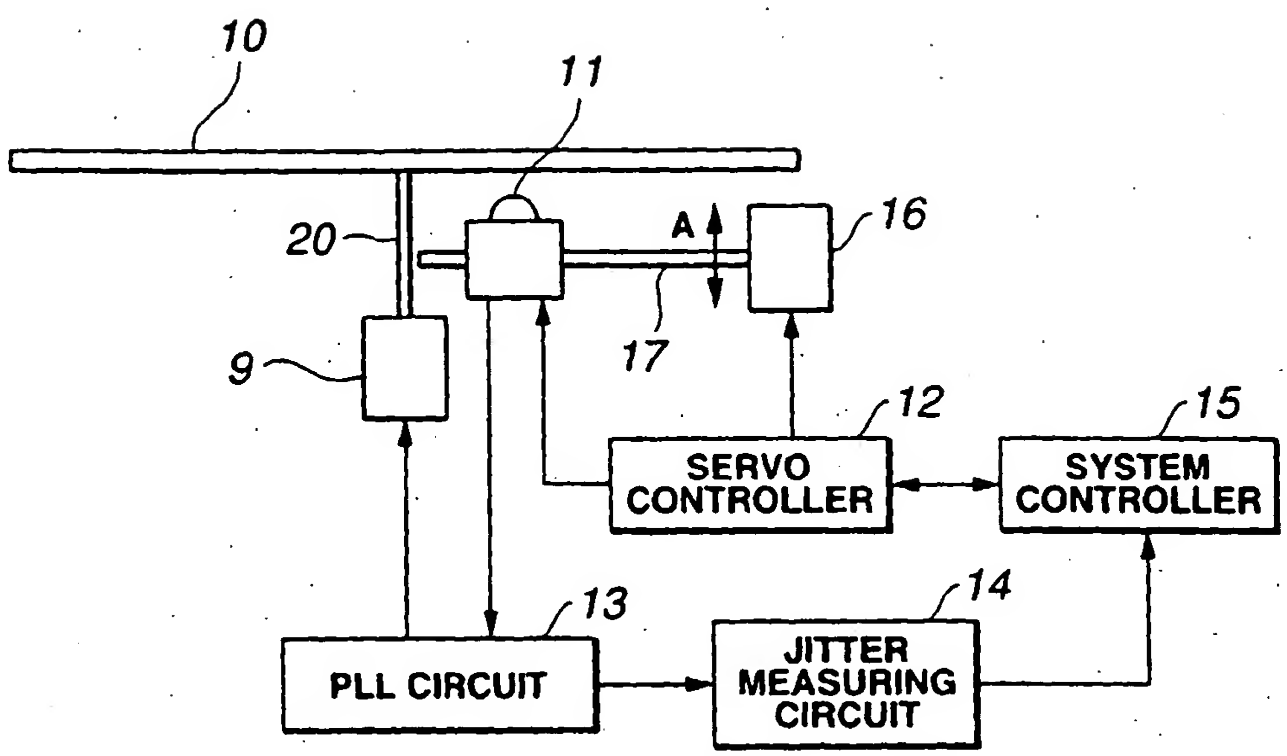
10
11
20
A
16
17
9
12
15
SERVO CONTROLLER
SYSTEM CONTROLLER
13
14
PLL CIRCUIT
JITTER MEASURING CIRCUIT

FIG.3

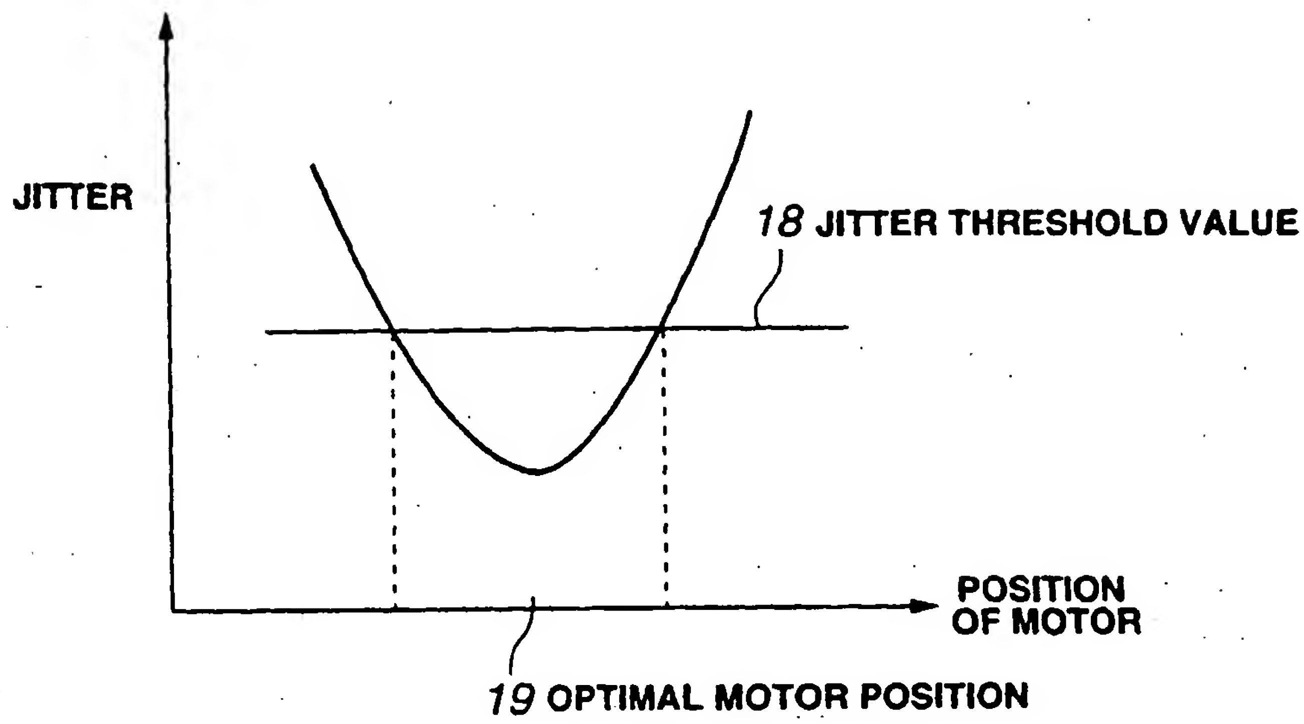
JITTER
18 JITTER THRESHOLD VALUE
POSITION OF MOTOR
19 OPTIMAL MOTOR POSITION

FIG.5

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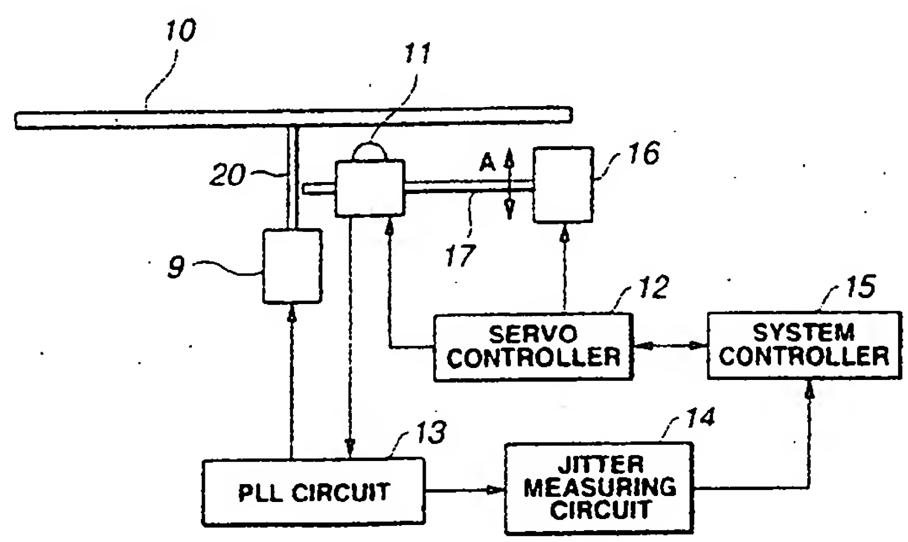

FIG.3

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 30 2608

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9726651	A	24-07-1997	WO	9726651 A1	24-07-1997
			EP	0875060 A1	04-11-1998
JP 08045081	A	16-02-1996	US	5898654 A	27-04-1999
EP 0984439	A	08-03-2000	CN	1244702 A	16-02-2000
			EP	0984439 A2	08-03-2000
			JP	2000057607 A	25-02-2000
			US	6282161 B1	28-08-2001

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